A Conceptual Design and Concept of Operations for Intermittent Short-Radius Centrifugation for Artificial Gravity

Completed Technology Project (2017 - 2021)

Project Introduction

The objective of this investigation is to fill a significant void in current countermeasures for spaceflight-induced human physiological deconditioning by creating and assessing the feasibility of a conceptual design and architecture for intermittent artificial gravity (AG). Future plans for long-duration spaceflight missions to the moon, asteroids, and Mars have created excitement across many disciplines regarding the possibility of humans once again traveling beyond low Earth orbit. Vehicle designs are underway for Mars exploration; however, previous research suggests that the duration of reduced gravity exposure for a Mars mission will lead to substantial physiological deconditioning in astronauts. This will not only impact the health of the crew, but an impaired crew could catastrophically impact mission success and safety. There are numerous countermeasures currently in use or proposed, but each one provides the means of combating deleterious effects of spaceflight of individual systems; thus a suite of countermeasures are required to keep the crew alive, healthy, and functional. Even then, for future 1000+ day missions and associated exposure to reduced gravity, these countermeasures may not be enough to correct the impeded ability of the astronauts to function effectively upon gravity transitions. AG is an integrated, comprehensive countermeasure that has the potential to mitigate deconditioning in multiple systems concurrently, and thus could be a game-changing technology for extended duration flight. However, today there exists a lack of baseline mission architecture for AG (i.e., low technology readiness level or TRL), and this uncertainty and absence of design has prevented its use as a countermeasure in flight. The goal of the current proposed research is to increase the TRL for AG and fill this gap by providing both a conceptual design and concept of operations for AG technology. Using a sequential approach, this research will include a systematic series of investigations and design iterations to recommend optimized parameters (i.e., angular velocity, gravitational loading, radius) for a short-radius intermittent centrifuge with an accompanying exposure prescription (i.e., for how per day long astronauts should be exposed to centrifugation). This investigation will conclude with a systems engineering analysis to estimate mass, power, volume, and cost of the optimized system to prove feasibility and provide a long-term solution for physiological deconditioning during extended-duration spaceflight.

Anticipated Benefits

This investigation hopes to provide a long-term solution for physiological deconditioning during extended-duration spaceflight.

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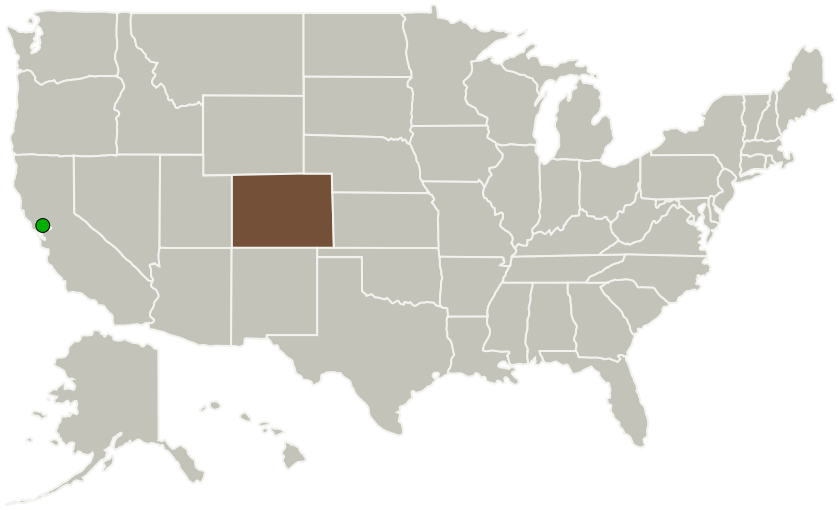
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Colorado Boulder	Lead Organization	Academia	Boulder, Colorado
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
Colorado

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Colorado Boulder

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Torin K Clark

Co-Investigator:

Kathrine N Bretl

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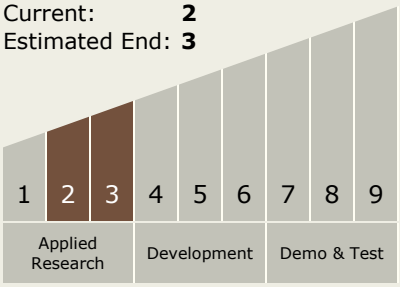
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.7 System Transformative Health and Performance Concepts

Target Destinations

The Moon, Mars, Others Inside the Solar System